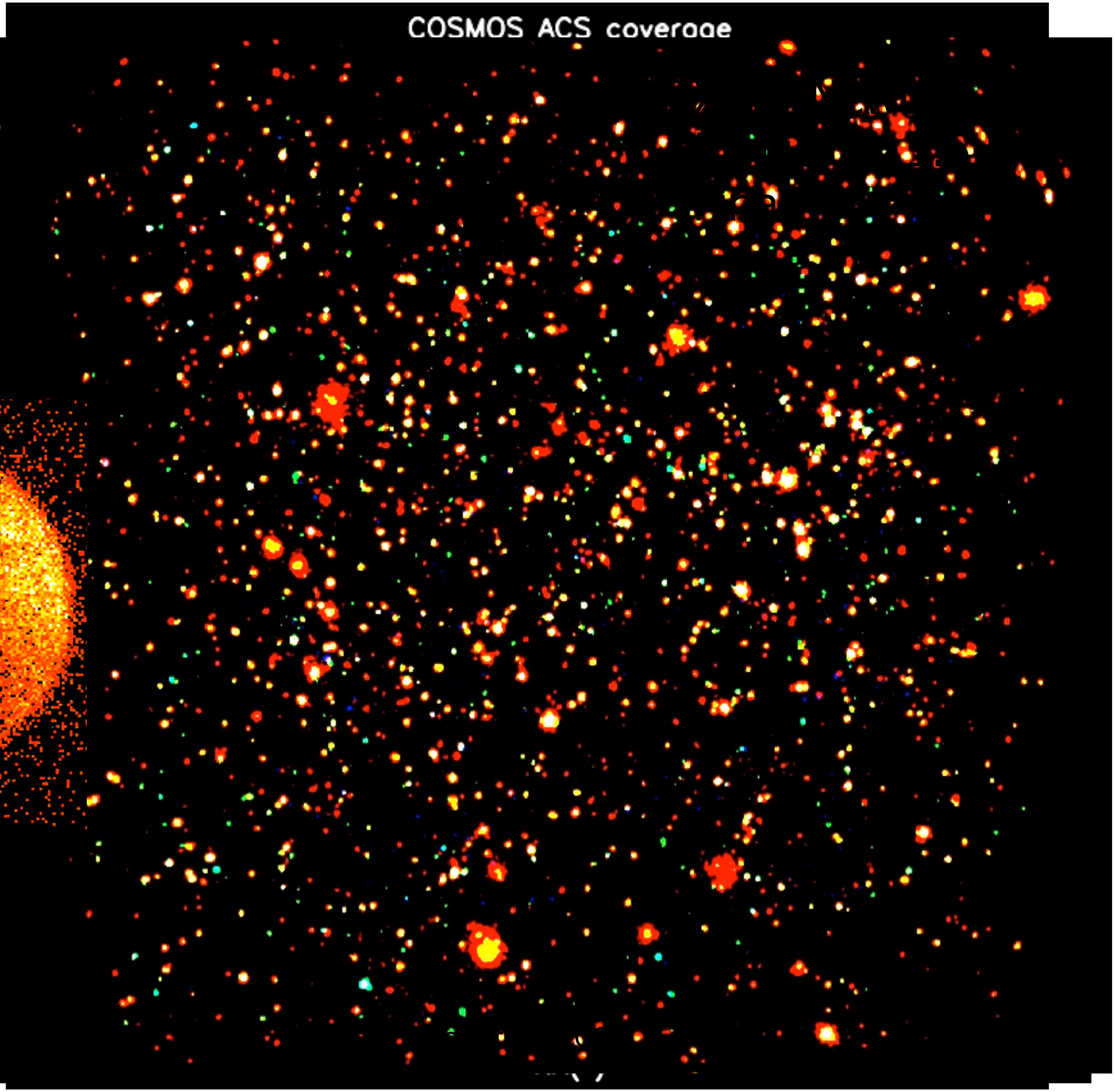
View on missing baryons from COSMOS

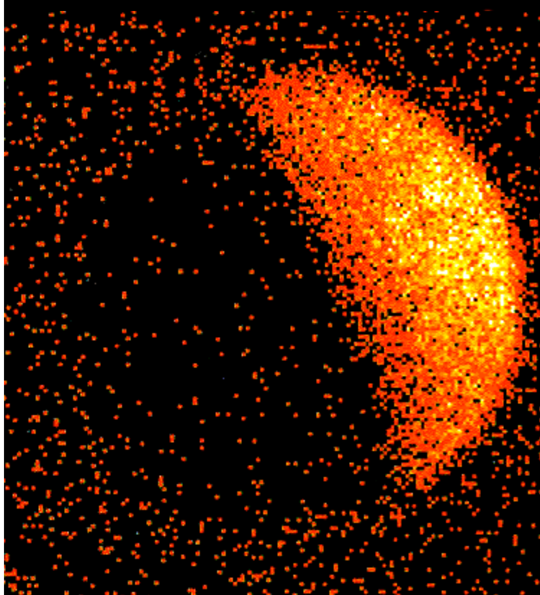
Alexis Finoguenov
MPE/UMBC

and the COSMOS team

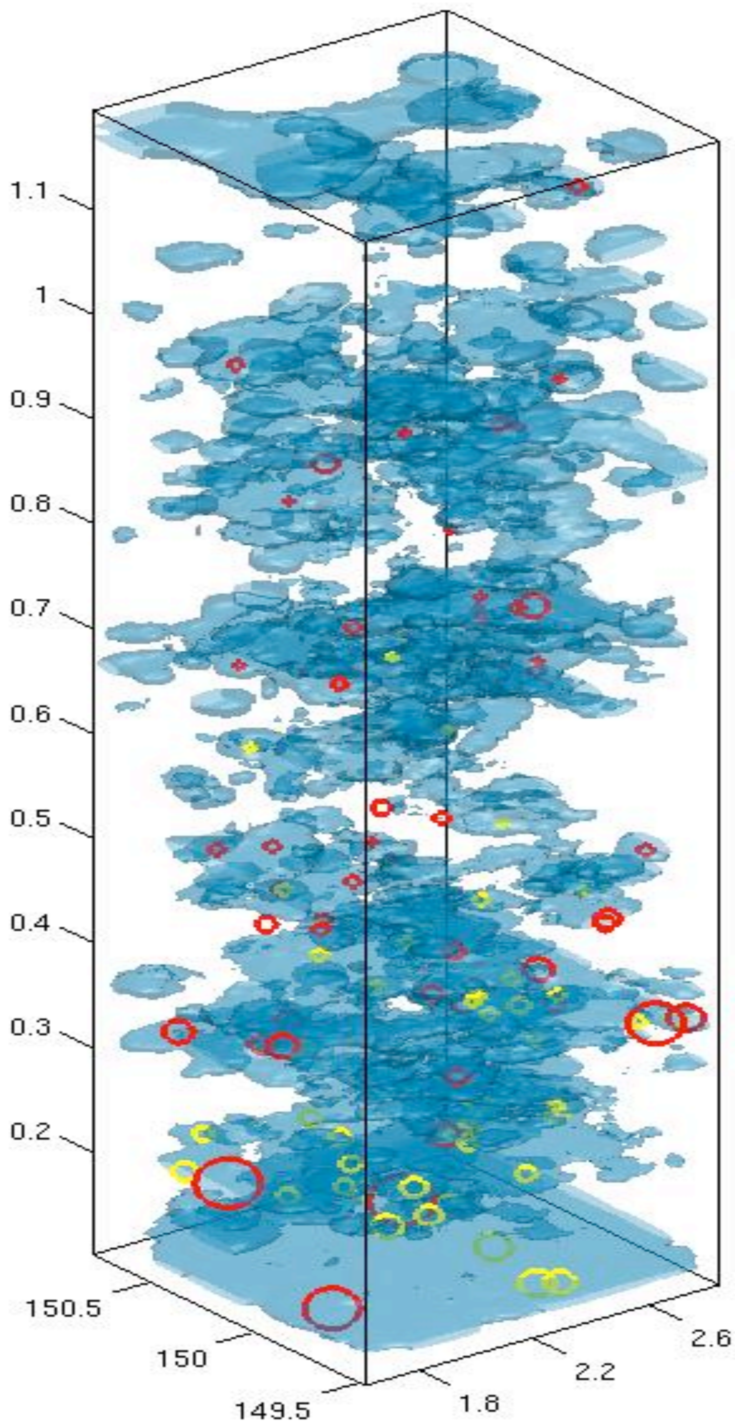
Cosmos Survey

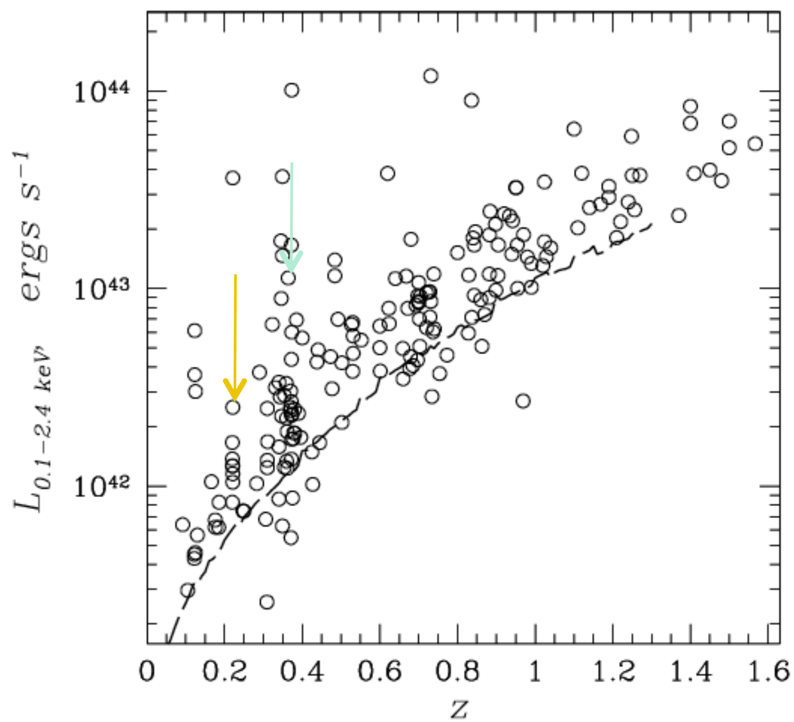
$2\ deg^2$





200 clusters in COSMOS



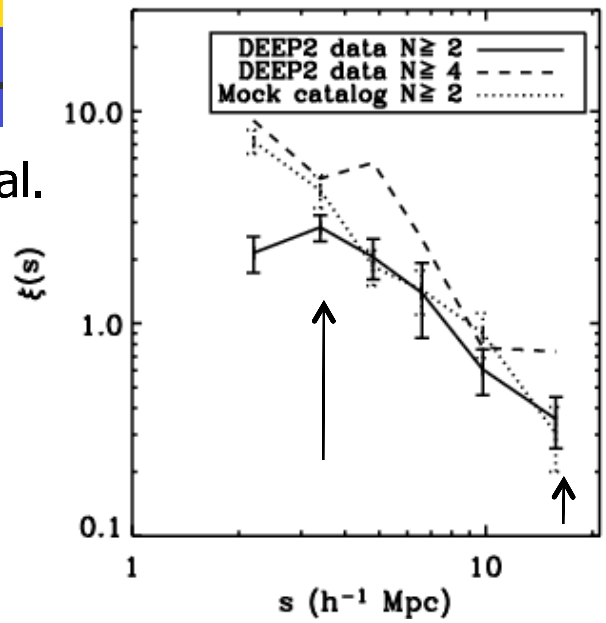


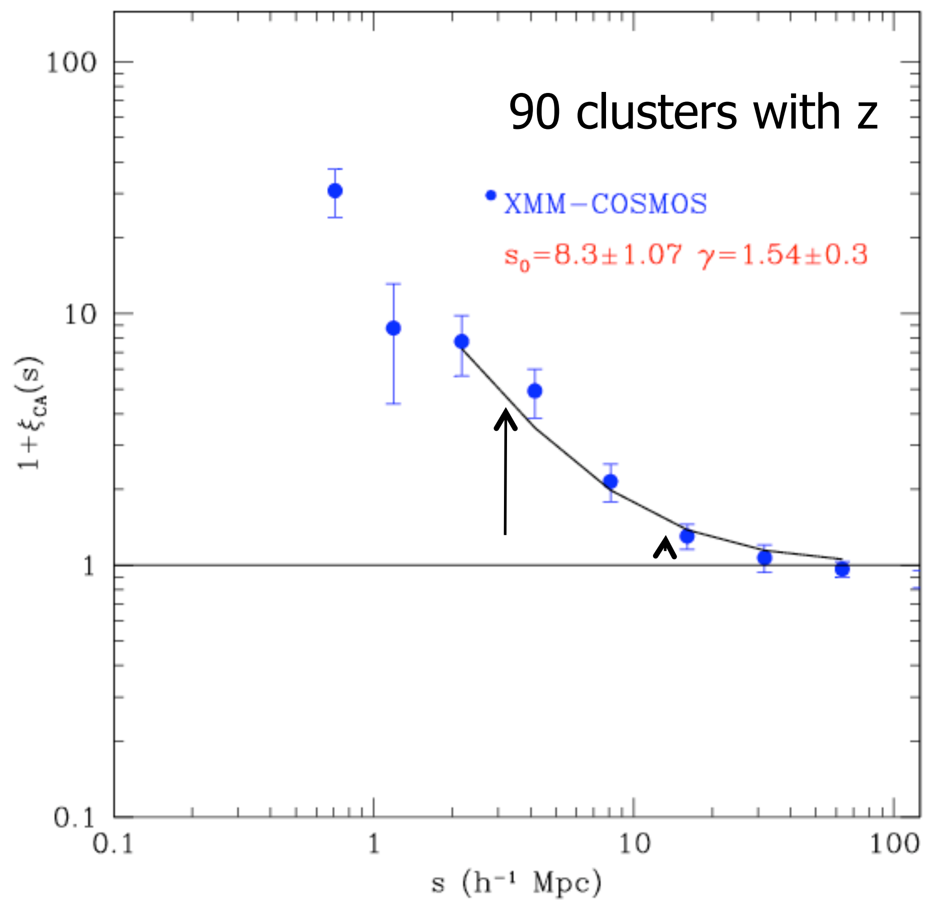
LSS at 0.13, 0.22, 0.34, 0.37, 0.51, 0.73, 0.89
(Optical groups:0.22,0.36,0.38)

K.Kovac
zCOSMOS (PI:Lilly)
10k I_{AB}<22.5

Redshift ACF for clusters

Coil et al. 2006



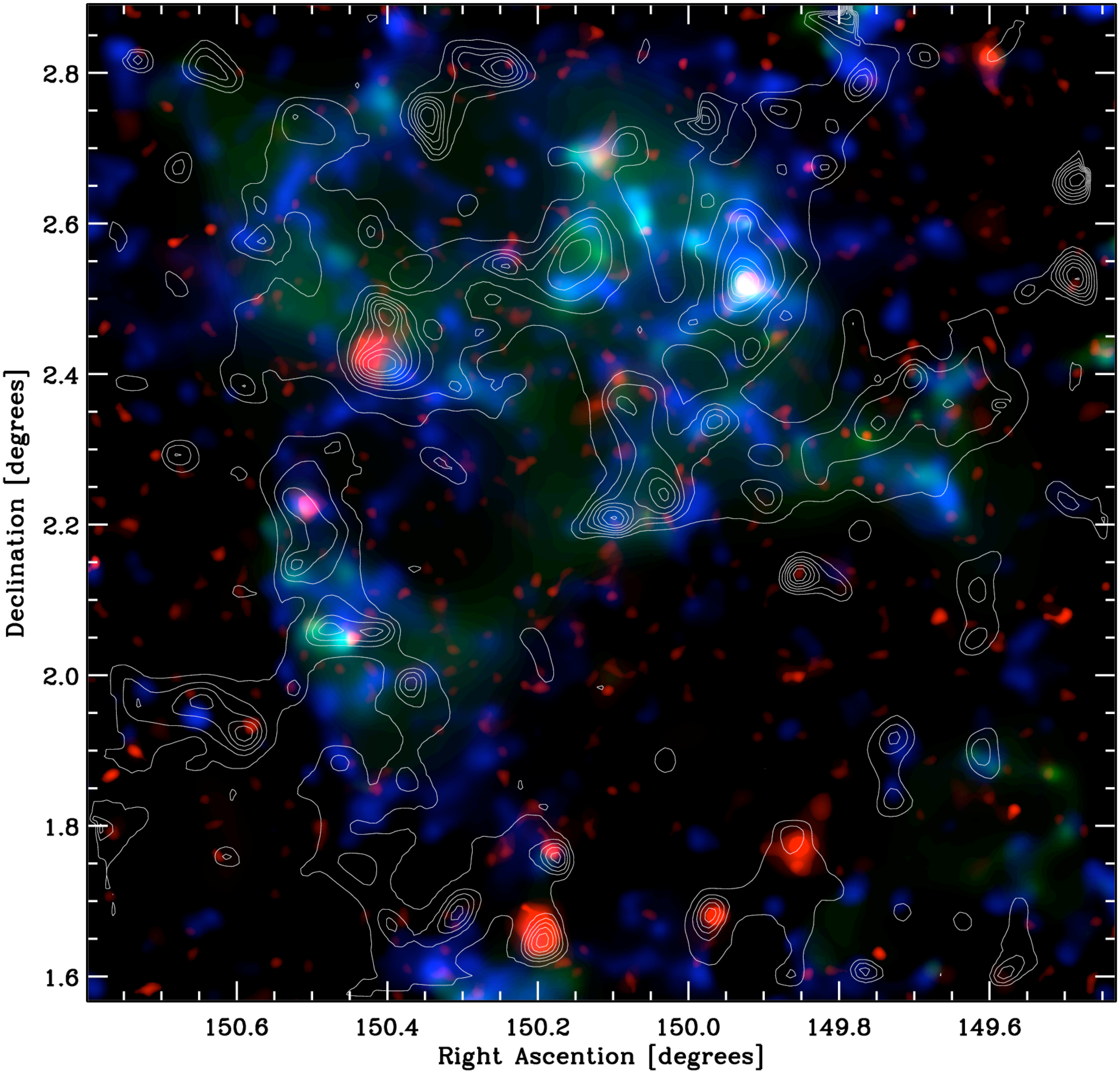


Using the ACF value at 10/h Mpc of 0.62+/- 0.10

b(z=0.26)= 1.66 +/- 0.3

Mvir = 2-8 10^13 solar mass

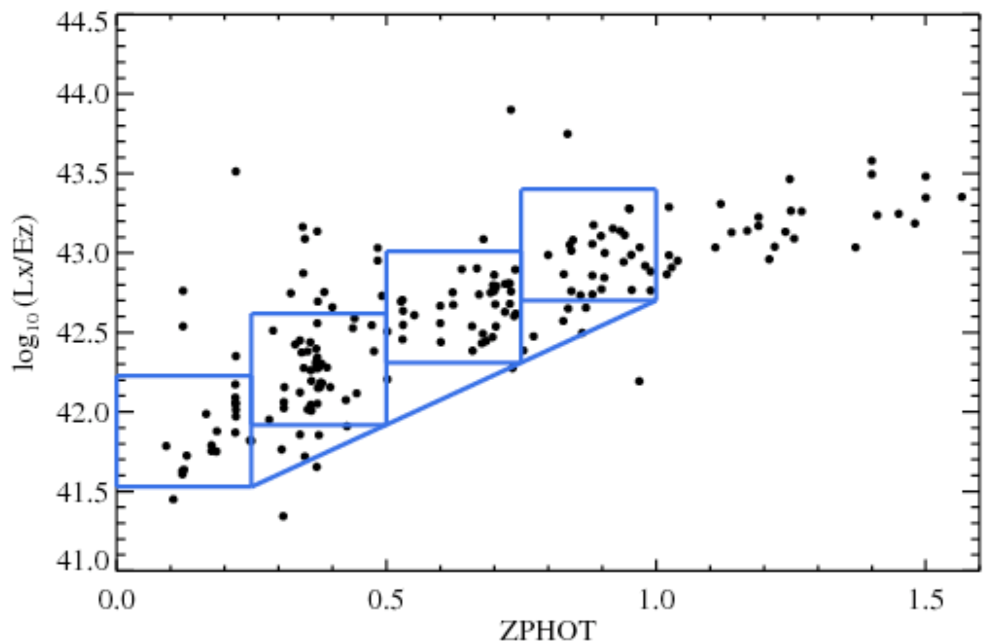
Nico Cappelluti

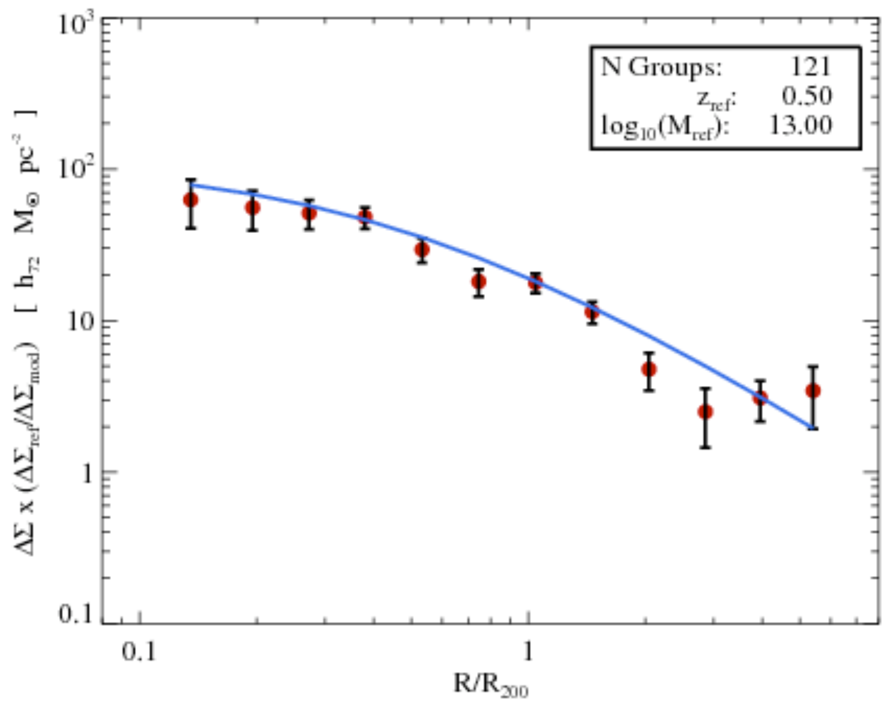


C O S M O S

Massey,A F, et al. 2007

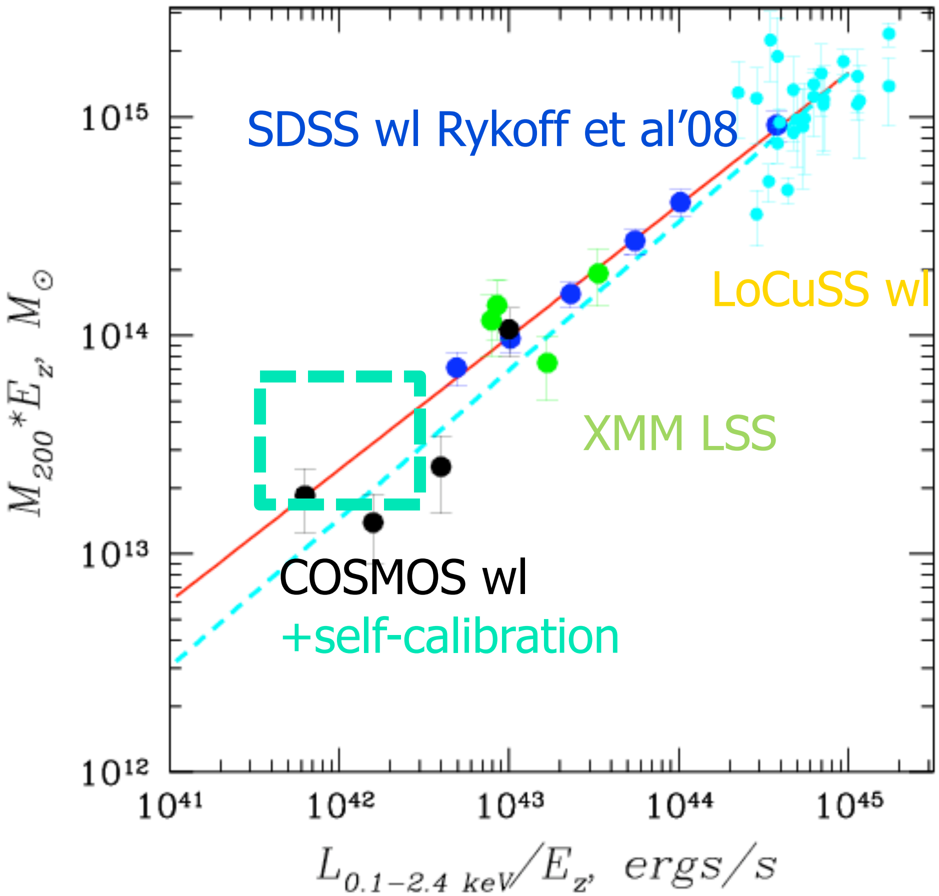
Stacked weak lensing in COSMOS



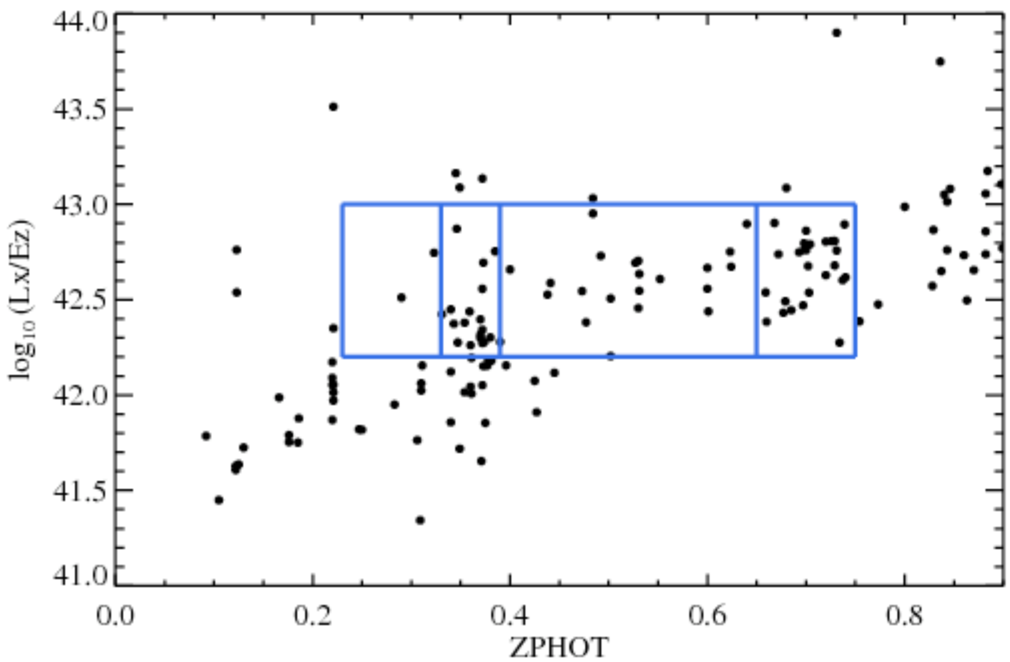


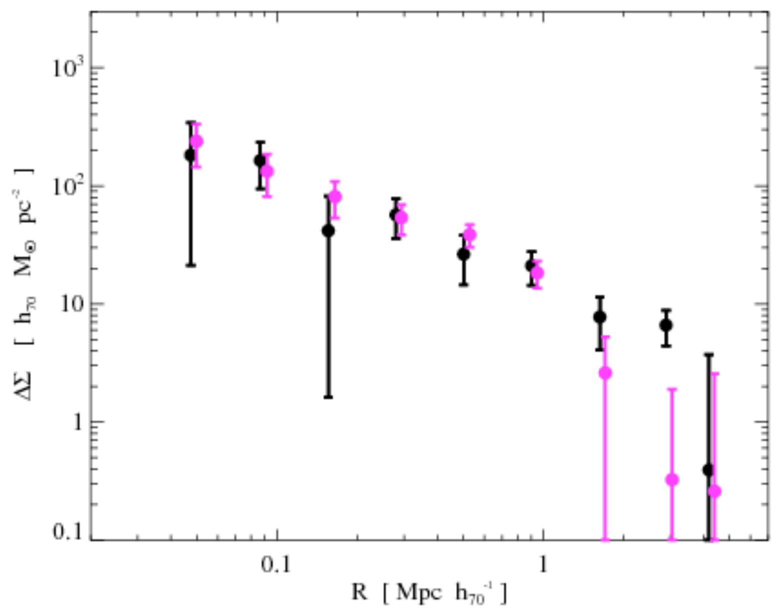
Leauthaud, AF et al. in prep.

L_X-M relation

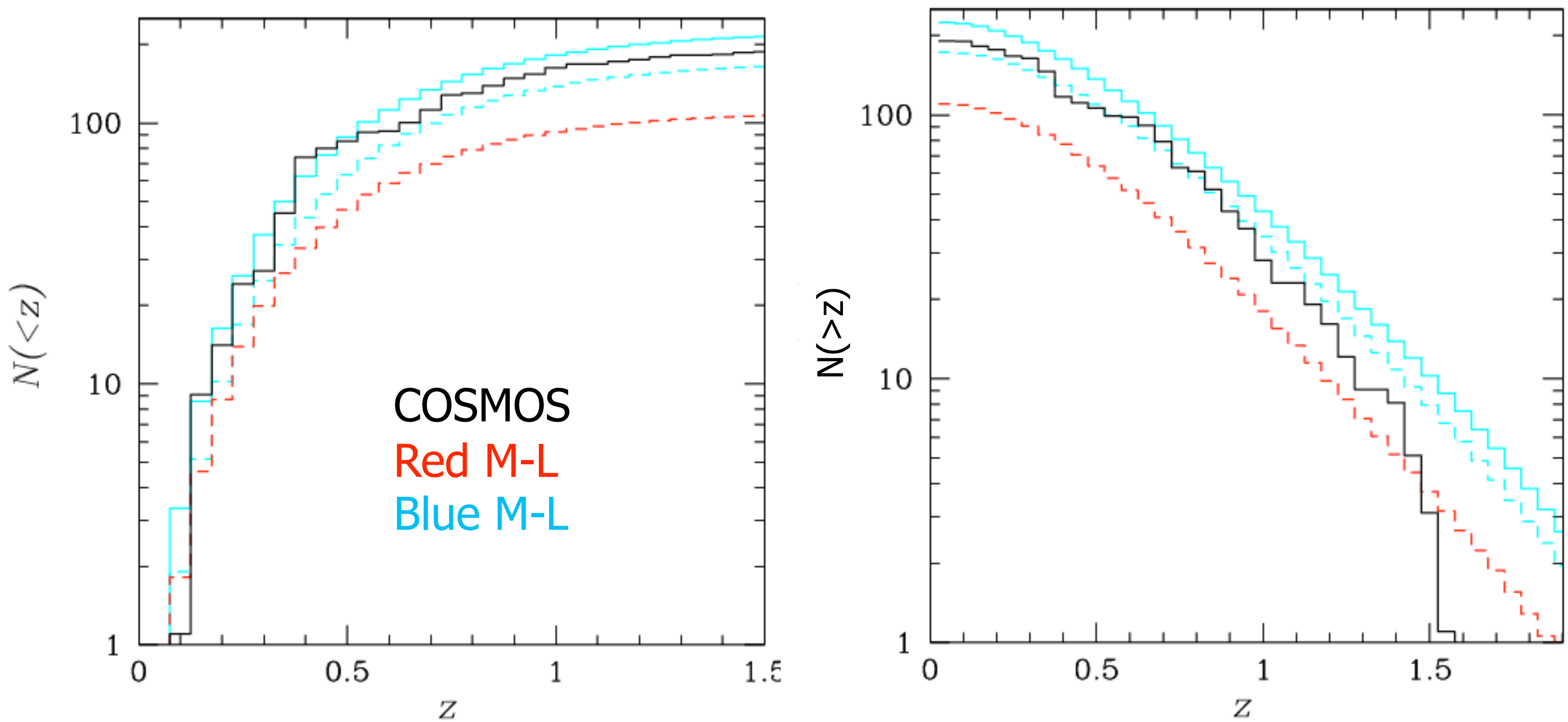


Testing LSS effects through weak lensing

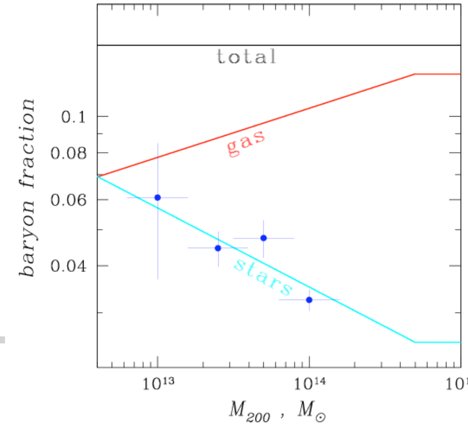




COSMOS vs WMAP-5 cosmology

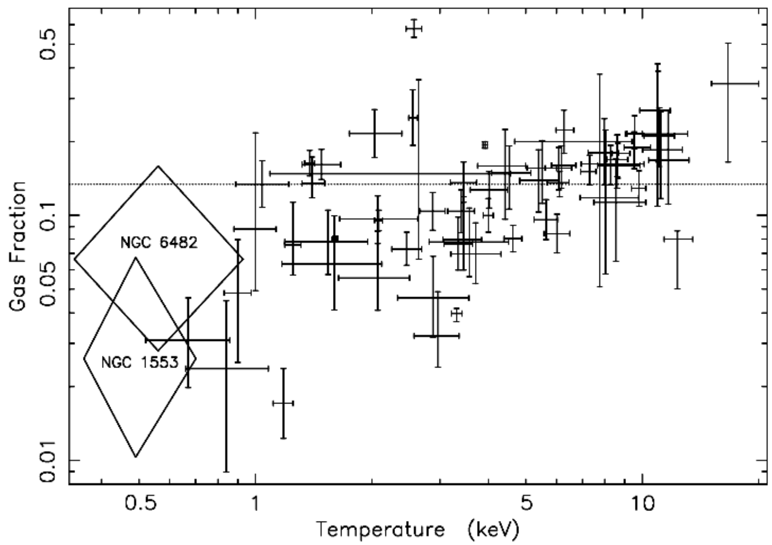


Baryons inside groups

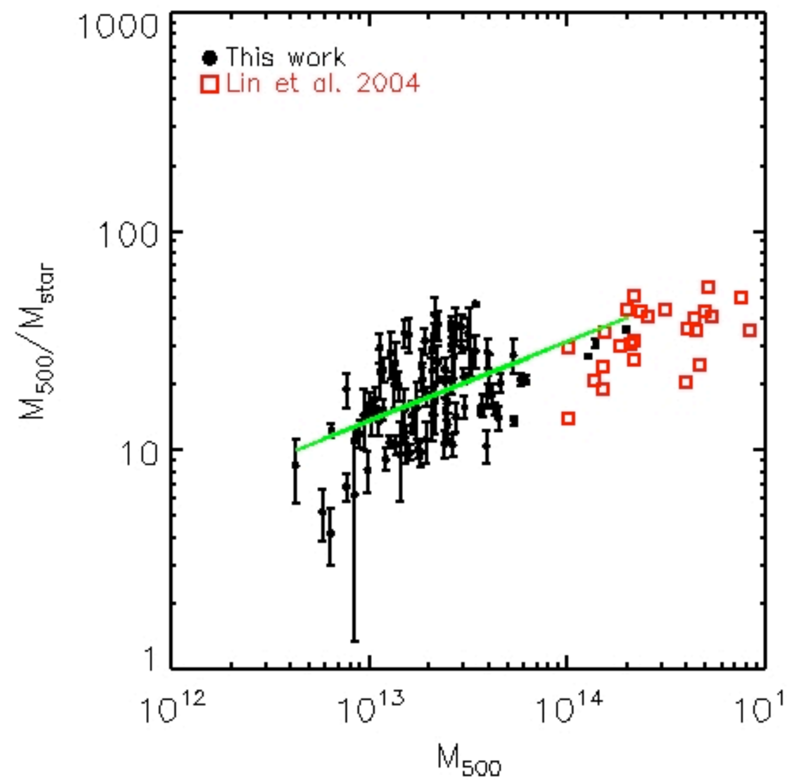


Less gas in groups

More stellar mass in groups

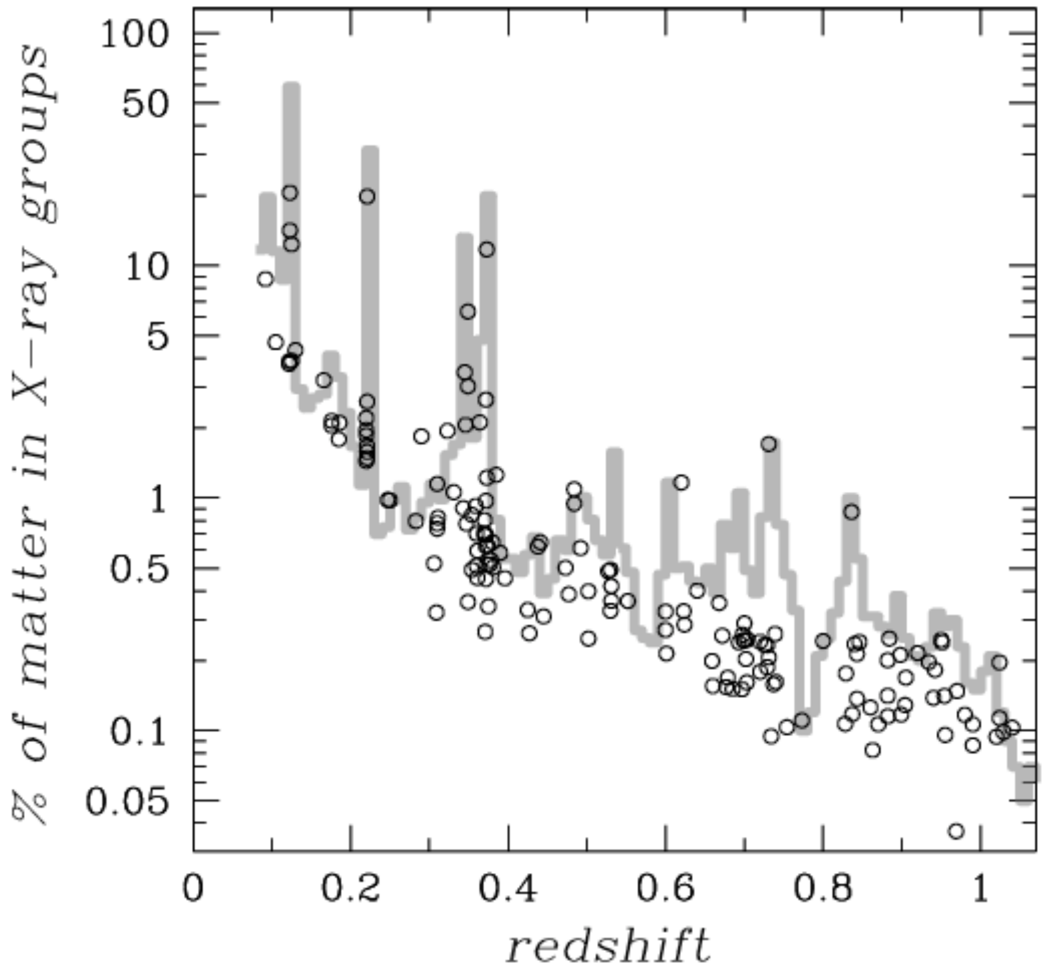


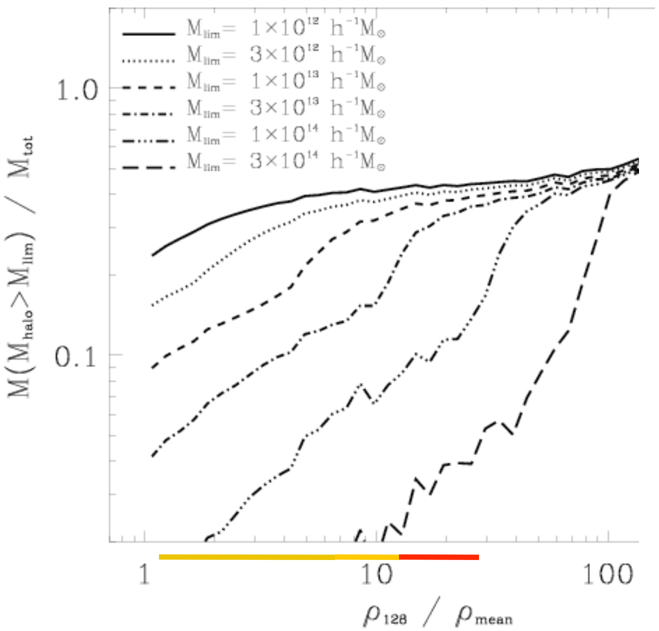
Sanderson, AF, et al. 2003



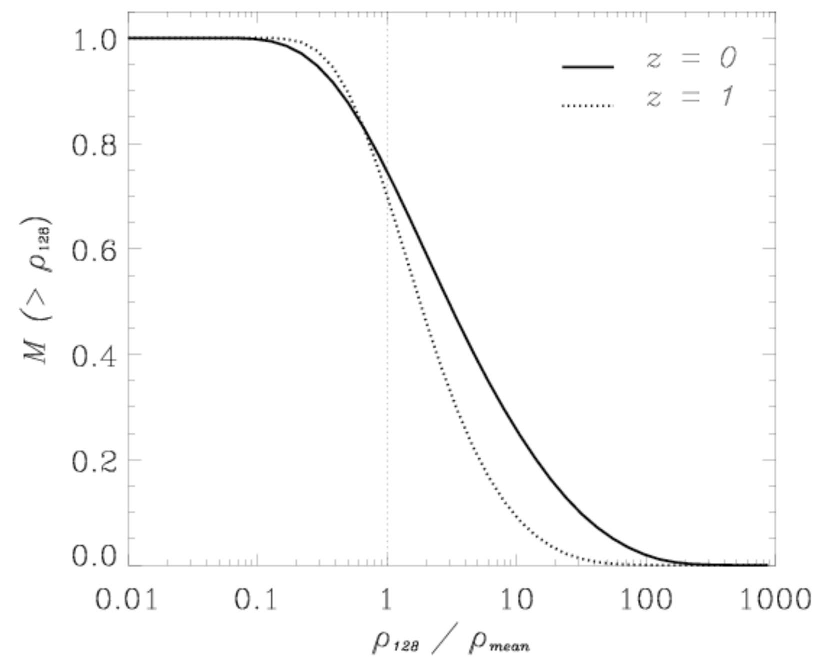
Giodini, AF, et al. 2008

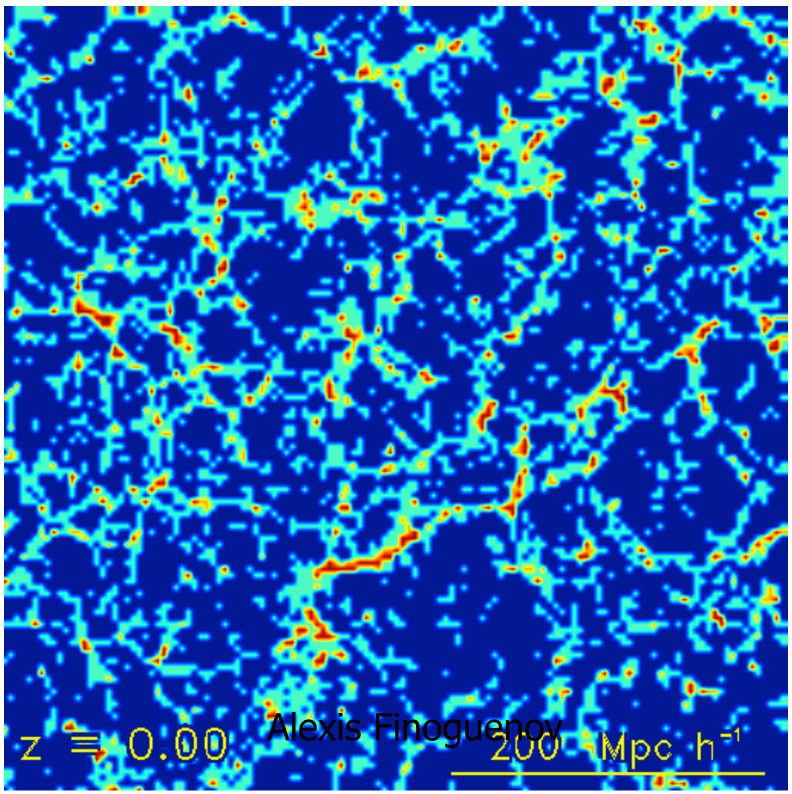
X-ray groups in mass budget of Universe





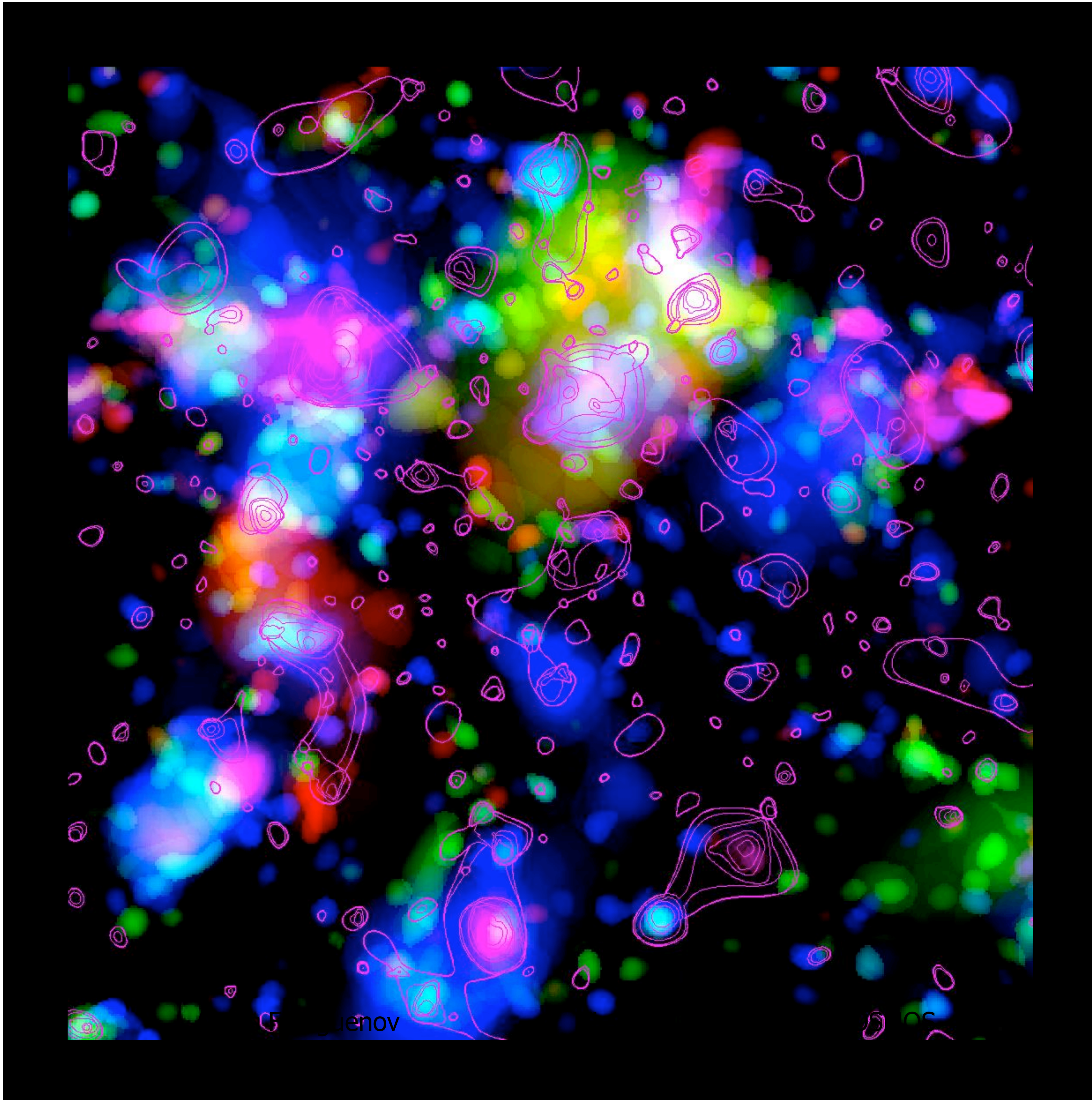
Fraction of matter resolved in groups





Simulations…

A. Faltenbacher, AF in prep.



C
O
S
M
O
S

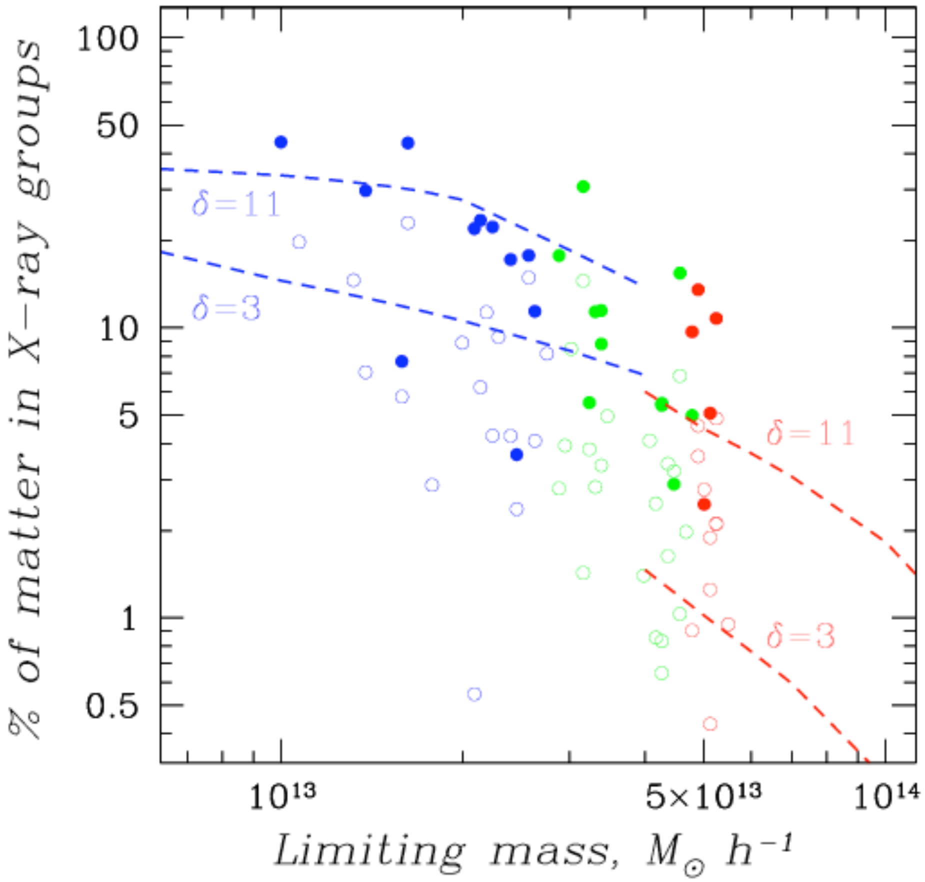
Photoz
z=0.8
z=0.6
z=0.4
z=0.2

$I_{AB}<25$

1.4Mio
galaxies

X-ray
contours

Resolving LSS with X-ray groups

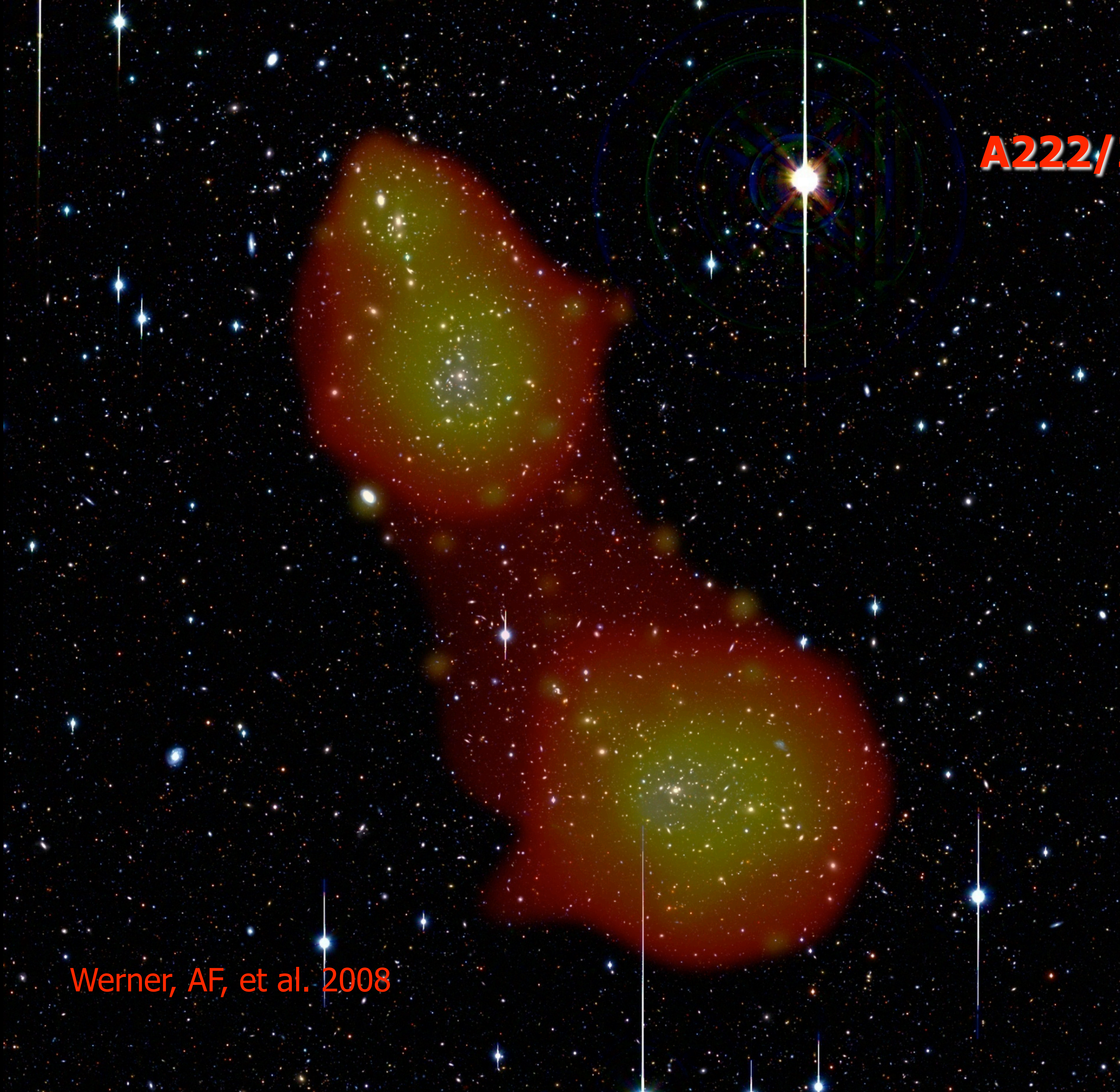


Conclusions

- **At low redshifts X-ray groups resolve 20-60% of matter in dense environments, thus playing there an important role in solving for baryons. Galaxies in groups contribute up to 50%.**
- **M-L relation based on weak lensing mass estimates is in agreement between COSMOS+LoCuSS vs SDSS work and also compares well to Reiprich and Boehringer 2002.**
- **Correlation analysis results in a similar mass associated with bulk of COSMOS X-ray groups.**
- **There seems to be no missing baryons inside groups**
- **Hunting for missing baryons should concentrate on delta~1-5. It does not have to be low-z. Galaxy redshift survey is a prerequisite for such studies.**

Surprise

A222/223



Werner, AF, et al. 2008

Do Abell 222 and Abell 223 Contain The Universe's 'Missing' Baryonic Matter?

Submitted by News Account on 7 May 2008 - 3:00pm. Astronomy

A team of Dutch and German astronomers have discovered part of the missing matter in the Universe using the European X-ray satellite XMM-Newton. They observed a filament of hot gas connecting two clusters of galaxies. This tenuous hot gas could be part of the missing "baryonic" matter.

Echoes of PR

Space oddity: European probe finds missing matter

An orbital X-ray telescope has found a chunk of matter in the universe whose existence had long been theorised but evidence for which had been lacking

Part of universe's missing matter 'uncovered' London (PTI): Astronomers have uncovered part of the missing matter in the universe, a discovery which they claim will help in understanding the evolution of the cosmic web in the future.

Found: Part of the Universe's missing matter
BY DR EMILY BALDWIN
ASTRONOMY NOW

Posted: May 7, 2008

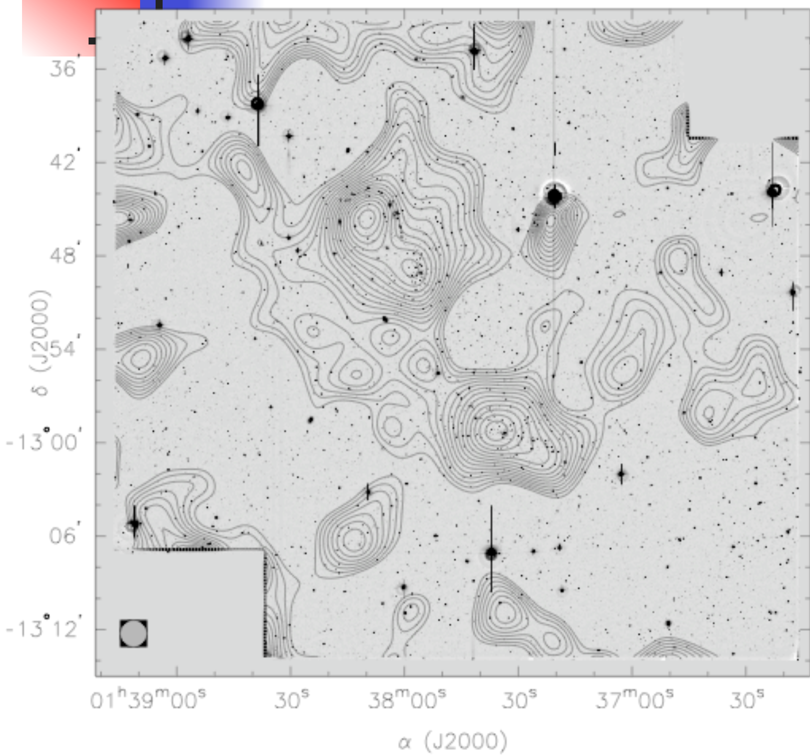
Using ESA's orbiting X-ray observatory XMM-Newton, a team of international astronomers has uncovered part of the missing matter of the Universe, in a filament of gas connecting two galaxy clusters.

Detection of hot gas in the filament connecting the clusters of galaxies Abell 222 and Abell 223

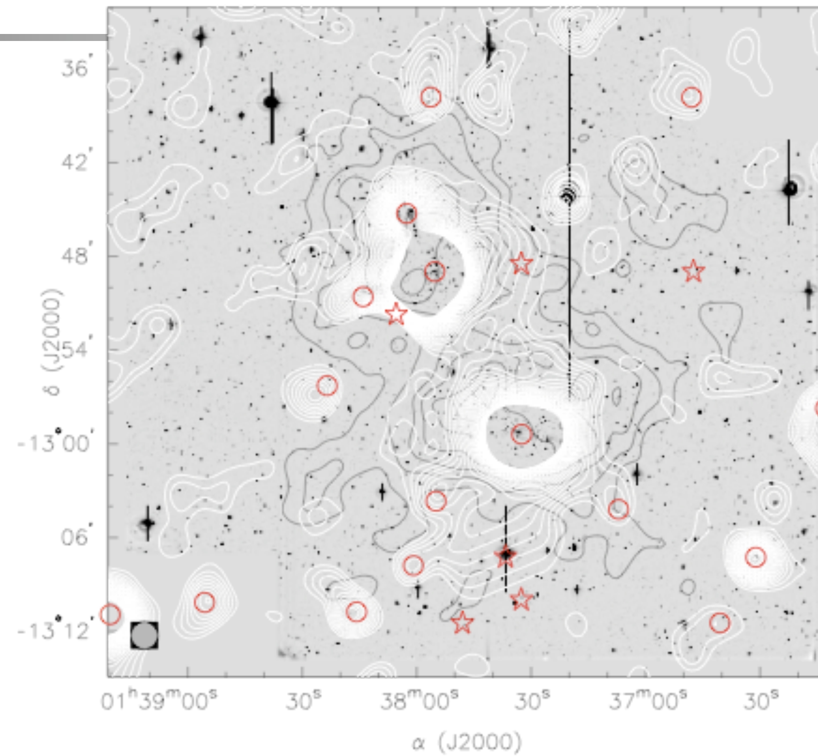
- N. Werner, A. Finoguenov, J.S. Kaastra,
- J.P. Dietrich, A. Simionescu, J. Vink, H. Boehringer

SRON
Netherlands Institute for Space Research

The pair of clusters Abell 222/223

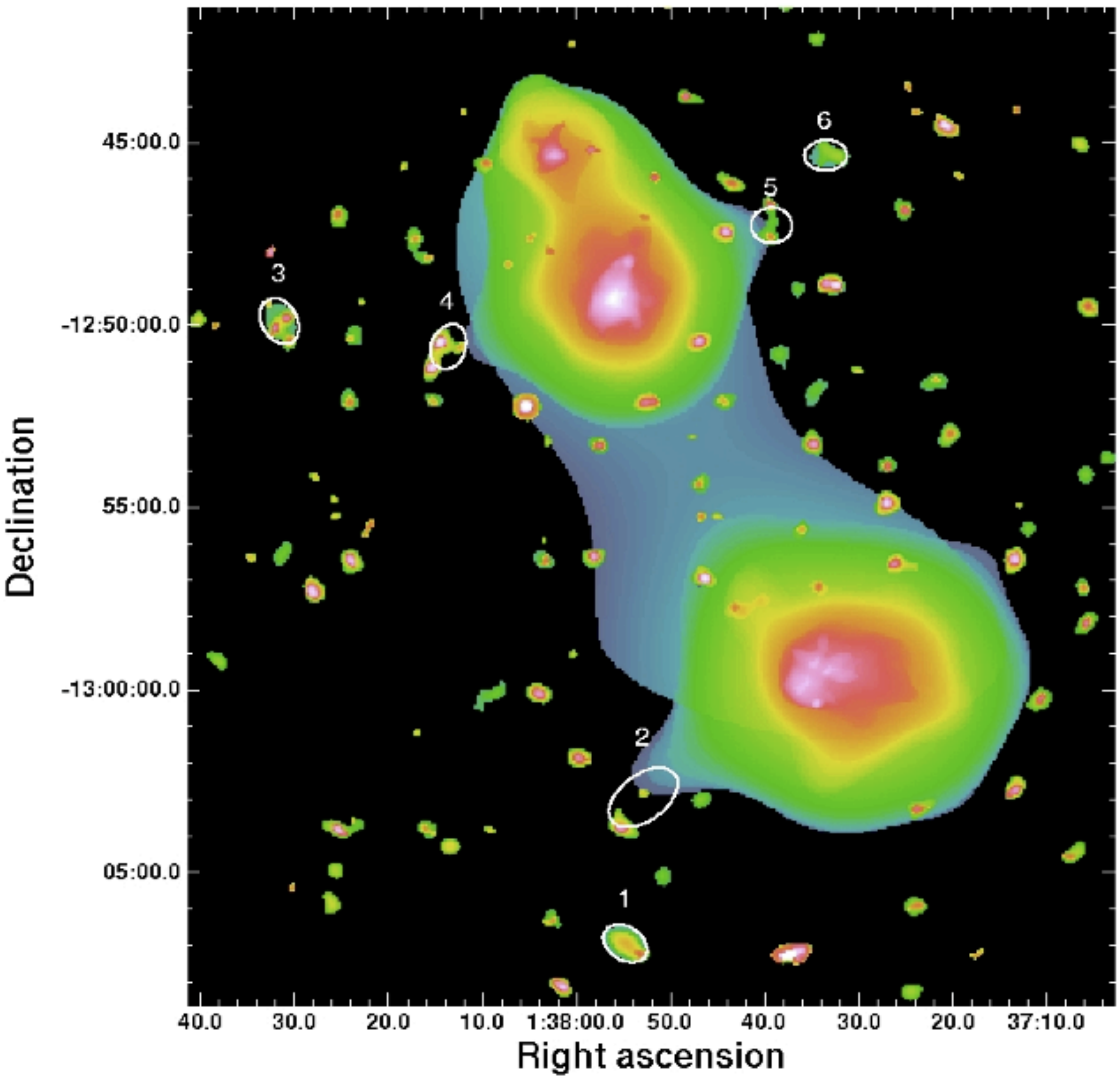


Weak lensing map (Dietrich et al. 2005)

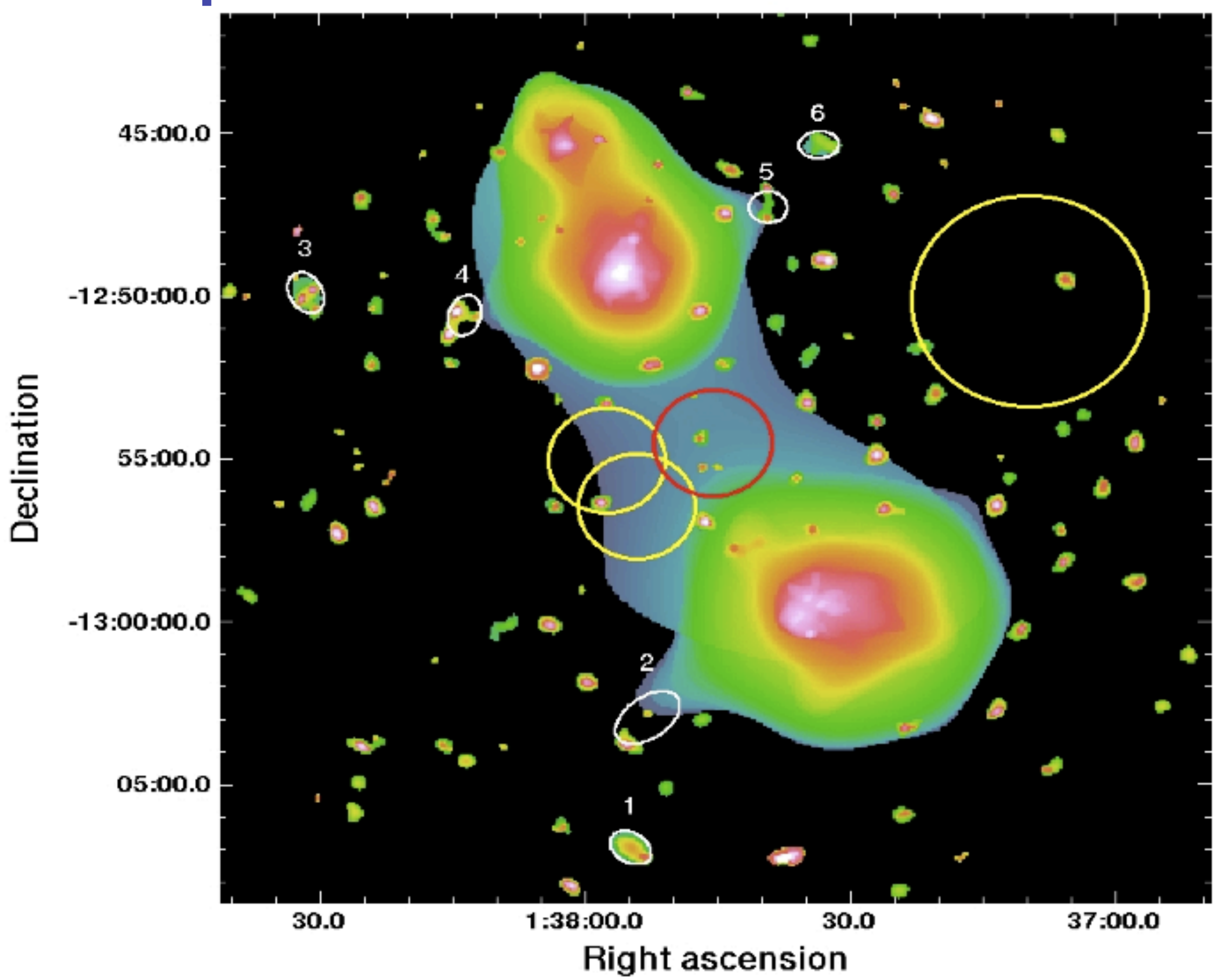


ROSAT PSPC + galaxy overdensity contours

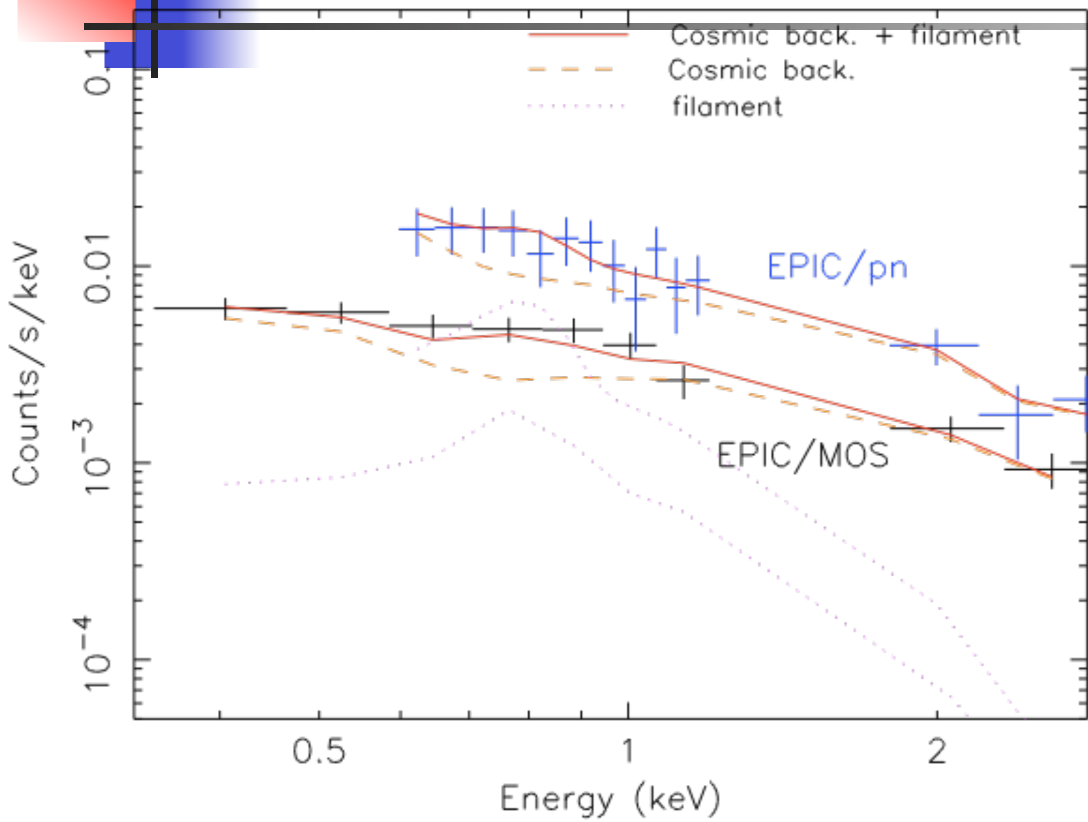
X-ray image of the cluster pair



Spectrum of the filament



Spectrum of the filament



$kT = 0.91 \pm 0.25$ keV

$Z = 0.2$ Solar

$EM = (1.72 \pm 0.67) \times 10^{65}$ cm^{-3}

$l = 15$ Mpc

$n = (3.4 \pm 1.3) \times 10^{-5}\ l^{-1/2}$ cm^{-3}

$\rho/\langle\rho\rangle \sim 150$

$kT / n^{2/3} \sim 870$ keV cm^2

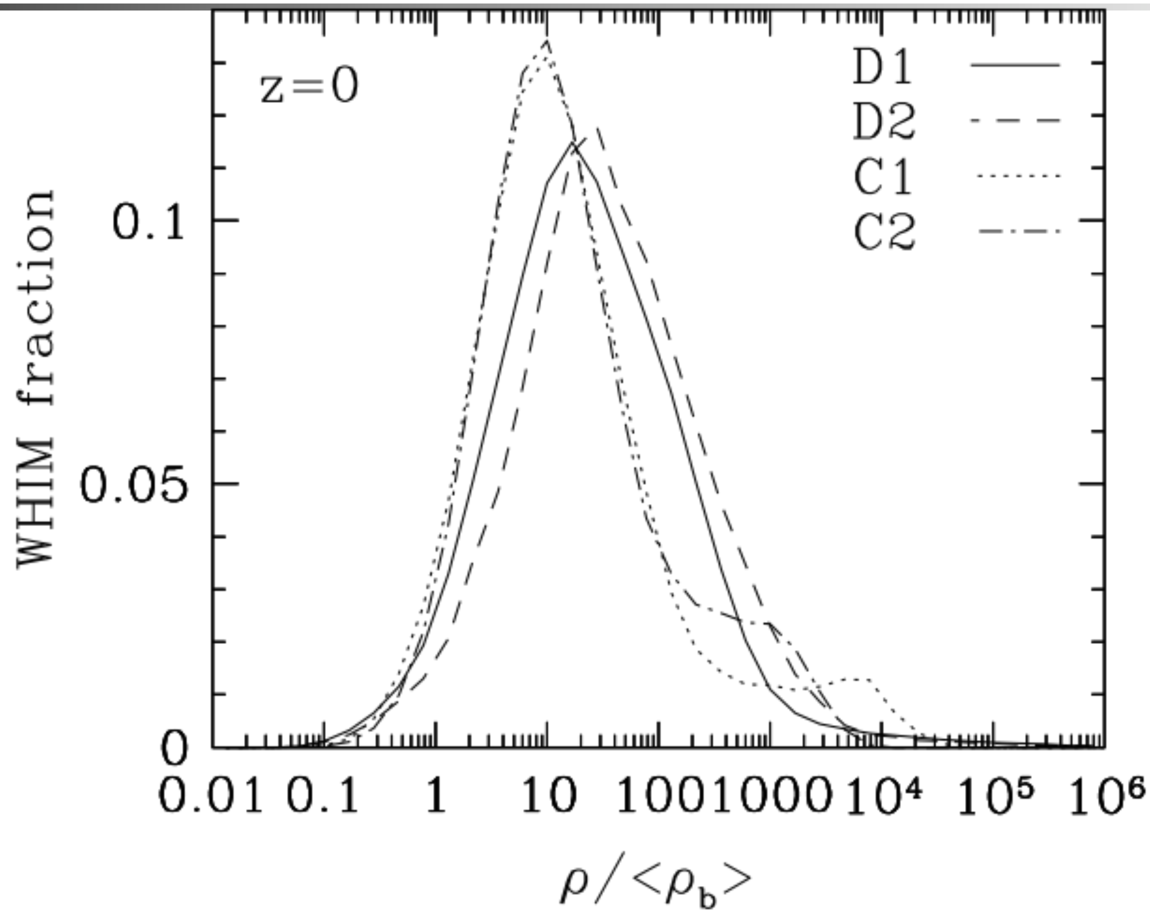
$M_{gas} \approx 1.8 \times 10^{13}$ M$_\odot$

$M_{tot} \approx 1.1 \times 10^{14}$ M$_\odot$

Conclusions

- we detect hot gas in the filament between the massive clusters A222 and A223
- the density of the gas is $n = (3.4 \pm 1.3) \times 10^{-5}\, l^{-1/2}$ cm^{-3} and the temperature $kT = 0.91 \pm 0.25$ keV
- we detect the densest and hottest parts of the warm-hot intergalactic medium

Do we detect the missing baryons?



Davé et al. 2001